A SUSTAINABLE DESIGN OF A MULTIPURPOSE HALL WITH RAINWATER HARVESTING SYSTEM AND A PASSIVE VENTILATION SYSTEM IN BRGY. POBLACION, NORZAGARAY, BULACAN

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Garay, Jhon Michael D.

Laran, Via Charisse A.

Nuguid, Nick Marie M.

Reyes, Sharon Flores

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RECOMMENDATION

This is to certify that this research entitled "A SUSTAINABLE DESIGN OF A MULTIPURPOSE HALL WITH RAINWATER HARVESTING SYSTEM AND A PASSIVE VENTILATION SYSTEM IN BARANGAY POBLACION, NORZAGARAY, BULACAN", prepared and submitted By Jhon Michael D. Garay, Via Charisse A. Laran, Nick Marie M. Nuguid, and Sharon F. Reyes been examined and PASSED the PRE-ORAL DEFENSE.

ENGR. ELOISA P. CADAG, Reg. CE., MACT
Research Adviser

PANEL OF EXAMINERS

Examined and approved by the Panel of Examiners in a Pre-Oral Defense with a Grade of _____ on November ___, 2025, at La Concepcion College, Bulacan.

Engr. WINIFREDO E. GONZALES
Chairman

Engr. CAROLINE A. ASUNCION Member

Engr. CAMILO A. BATULAN JR., MSCM Member

Accepted as partial fulfillment of the requirements for the degree of Bachelor of Science in Civil Engineering.

ENGR. JORE GIL D. GALEZA Meng, PhD
Dean of Engineering Department

LEILANI CUSACK, Phd, DBA
Dean of Instruction

CERTIFICATE OF ORIGINALITY

This certificate hereby verifies that this was originally made by the researchers and that no research has been previously written or published by another person or organization, not even any awards and recognition materials from other colleges and universities or other tertiary learning institutions have been asserted hereto, except where due acknowledgment is made thereof.

Furthermore, we declare that the intellectual content of this thesis is the product of our thorough endeavors by harnessing group fresh ideas, and utilizing simple language and style as can be observed in the manner of our representation.

Jhon Michael D. Garay

Via Charisse A. Laran

Nick Marie M. Nuguid

Sharon F. Reyes

Attested by:

Engr. Eloisa P. Cadag, Reg. CE., MACT

Research Adviser

Date: _____

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CHAPTER 1

The Problem and its Background

This chapter includes the introduction, the background of the study, the theoretical framework, the conceptual framework, the statement of the problem, the objectives of the study, the hypothesis, the significance of the study, the scope and delimitation of the study, and the definition of terms.

Introduction

A multipurpose hall provides a flexible space for various activities. This serves as a place that supports the social, educational, economic, and emergency needs of a Barangay. This facility benefits not only the community but also the local government unit by ensuring the residents gain access to growth and inclusion socially. However, Barangay Poblacion, Norzagaray, Bulacan, has yet to provide.

As we experience a scarcity of water supply and increasing heat index all over the world, it is essential to focus on how we can conserve resources while keeping structures functional. This thesis aims to address this issue by designing a multipurpose hall that conserves water by using a water supply from a rainwater harvesting system as an alternative, and to integrate a passive ventilation system to reduce energy consumption and maximize natural alternatives. By doing so, this hall becomes a self-reliant space that is sustainable, while still providing comfort.

This study aims to demonstrate that civil engineering isn't just about calculations and concrete. It is also about serving people. By integrating structural design with consideration of our environment, the proposed multipurpose hall becomes more than just a physical space. It stands as an example of how communities like Barangay Poblacion can build smarter, more sustainable, and more resilient spaces that truly respond to local needs.

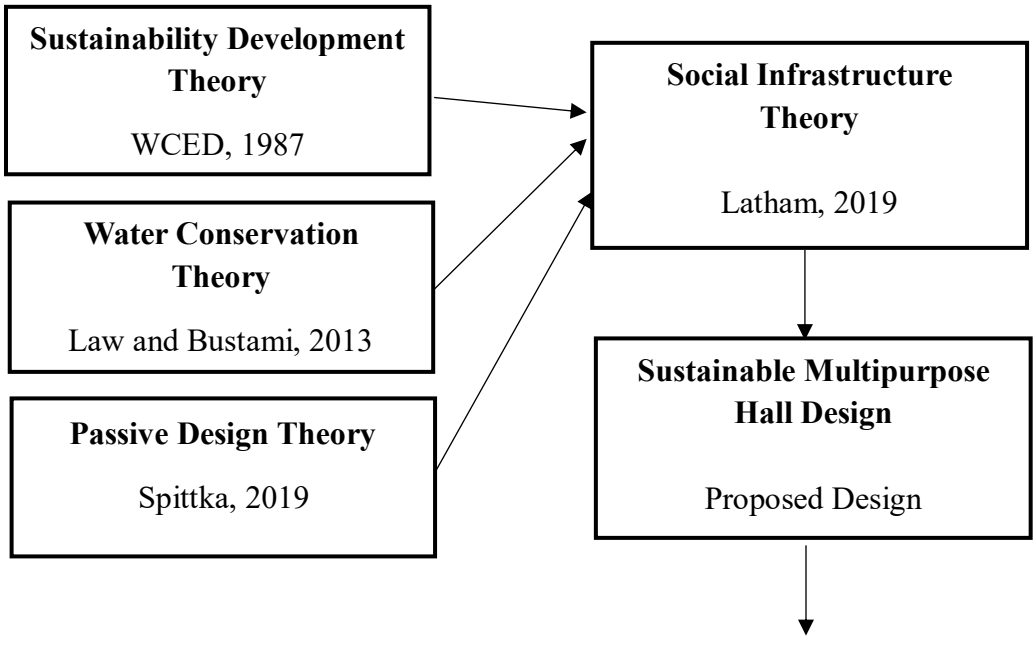
Background of the Study

Norzagaray is a municipality of Bulacan known for its natural and industrial resources, including Angat Dam, Ipo Dam (sources of water in Metro, Manila), and its mountain areas. It is close to Metro Manila, and continues to grow as more people settle in this area. Despite this town being developed, it's still struggling and faces problems like flooding, a lack of public spaces, and health concerns in some communities. These issues show the need for more facilities that can help people in times of need and support community activities.

Currently, most barangays in Norzagaray still depend on covered courts or small community halls, which are often too small and lack the needed facilities to serve the growing population. When disasters like typhoons or dam water releases occur, evacuation centers quickly become full, and government activities such as programs or public meetings struggle because there is no proper venue that is easy to reach and well-prepared for such needs. This situation affects the delivery of services and limits the community's readiness and involvement.

Building a multipurpose hall near the municipal hall is seen as a good solution to these problems. Being close to the center of local government makes it easier to coordinate during emergencies, organize programs, and provide a convenient place for residents from different barangays. A properly planned multipurpose hall can serve many uses—it can be an evacuation site, a place for health and livelihood projects, community meetings, youth and cultural events, and public awareness activities. Most importantly, it can give people a safe and dependable shelter during disasters, especially since flooding and other environmental risks continue to affect the town.

Theoretical Framework



This study is anchored by four theories that direct the integration of sustainable features into the Sustainable design of a Multipurpose Hall in Barangay Poblacion, Norzagaray, Bulacan. Social Infrastructure and Sustainable Development Theory establishes the purpose and guiding principle, while Passive Design and Water Conservation Theory provide practical and design-based solutions. These theories are relevant to this study as they help the researchers to understand how integrating sustainable features can address resource and environmental challenges, thereby promoting a safer and resilient community.

Figure 1: *Theoretical Framework illustrates theories from various studies*

IPO Conceptual Framework

INPUT	PROCESS	OUTPUT
1. What is the demographic profile of the	1. Survey questionnaires for residents 2. Site	1. An assessment report summarizing the demographic profile of respondents. 2. Identified problems caused by absence of multipurpose hall,

respondents in terms of: 1.1. Age 1.2. Gender 1.3. Length of residency 2. How does the absence of a multipurpose hall affect the community gatherings and public services in their barangay in terms of: 2.1. Venue availability for community gatherings that lack a permanent space. 2.2. Preparedness	Observation 3. Informal interview 4. Statistical Treatment 5. Design Planning 6. Cost Estimation	and an evaluation of community needs. 3. Feasibility evaluation of the multipurpose hall's potential to meet community needs including estimated improvements in terms of water resource availability, cost efficiency, and emergency preparedness capacity through systems such as rainwater harvesting and passive ventilation.

for emergencies and disasters without enough designated evacuation or activity centers. 2.3. Community participation and inclusivity, which may be limited due to the absence of a facility. 2.4. Efficiency issues in conducting activities in borrowed areas, which often lead to higher energy consumption due to the absence of energy-efficient design.		

3. How can the design of a sustainable multipurpose hall with a rainwater harvesting system and passive ventilation system provide solutions and improvement to community needs in the said barangay, be measured in terms of: 3.1. Long-term use 3.2. Cost-efficiency 3.3. Self-sustaining facility		

Table 1: *IPO Conceptual Framework*

Statement of the Problem

In this study, the researchers aim to determine the data that needs to be considered in the process of designing the multipurpose hall of Barangay Poblacion,

Norzagaray, Bulacan. Furthermore, the researchers seek to answer the following questions:

1. What is the demographic profile of the respondents in terms of the respondents in terms of:

    1.1. Gender

    1.2. Age

    1.3. Length of Residency

2. How does the absence of a multipurpose hall affect the community gatherings and public services in their barangay?

    2.1. Venue availability for community gatherings that lack a permanent space.

    2.2. Preparedness for emergencies and disasters without enough designated evacuation or activity centers.

    2.3. Community participation and inclusivity, which may be limited due to the absence of a facility.

3. How can the design of a multipurpose hall with a rainwater harvesting system and passive ventilation system provide solutions and improvement to community needs in the said barangay, be measured in terms of:

    3.1. Long-term use

    3.2. Cost-efficiency

    3.3. Self-sustaining facility

Objectives of the Study

The researchers aim to achieve the following objectives. The results will be helpful for people who want to adopt the design of the multipurpose hall and resolve similar issues in Barangay Poblacion, Norzagaray, Bulacan.

1. Improving thermal comfort in public spaces without excessive consumption of energy or resources.
2. To provide a public space for community gatherings and public services in the said barangay.
3. To assess whether a multipurpose hall can provide functionality while operating as a nearly self-sustaining facility.
4. To evaluate whether a nearly self-sustaining facility can be scaled to a broader context while maintaining long-term effectiveness.

General Objective

To design the multipurpose hall of Barangay Poblacion, Norzagaray, Bulacan.

Specific Objective

- By designing the multipurpose hall to maximize effectiveness in serving its intended functions.
- Conducting surveys on the residents of Barangay Poblacion, Norzagaray, Bulacan, to integrate their insights into the design process.
- By identifying the sources of materials while selecting appropriate materials for the proposed design.

Hypothesis

Ha. The implementation of a sustainable design for a multipurpose hall with a rainwater harvesting system and a passive ventilation system significantly enhances water conservation, reduces energy consumption, and improves indoor environmental comfort in Barangay Poblacion, Norzagaray, Bulacan.

Ho. The implementation of a sustainable design for a multipurpose hall with a rainwater harvesting system and passive ventilation system does not significantly improve the building's sustainability, water conservation, or indoor environmental comfort in Barangay Poblacion, Norzagaray, Bulacan.

Significance of the Study

This study is important for many people who are planning, designing, or improving community buildings. It gives ideas on how to make structures more useful, safe, and friendly to the environment. It also shows how using simple designs like rainwater harvesting and passive ventilation can help save energy and water, which is good for both people and nature.

For Future Researchers – This study can help future students and researchers who want to learn more about sustainable building designs. It can serve as a guide for those who plan to study the use of natural ventilation and rainwater collection in their own projects. It will also help them gain more ideas on how to design buildings that are eco-friendly and practical for the community.

For the School and Professors/Instructors – This research can be used as an example in teaching lessons about sustainable design and construction. It can help teachers explain how simple but smart designs can solve real problems in the community. It also supports the school's goal of promoting projects that care for the environment and serve the people.

For Local Residents – The study is meaningful to the people of Barangay Poblacion, Norzagaray, Bulacan. The proposed multipurpose hall will give them a safe place to stay during disasters like floods and typhoons. It can also be used for meetings, programs, and training that can help improve their daily lives. Having this kind of facility can make the community more united and prepared in times of need.

Government – This study can serve as a guide for the local government in building safe, useful, and sustainable public structures. It shows how including features like rainwater harvesting and natural ventilation can help the town save money and protect the environment. It can also inspire other municipalities to build facilities that are strong, eco-friendly, and helpful to the people.

Scope and Limitation

This study centers on creating a design for a multipurpose hall in Norzagaray, Bulacan, to be built near the municipal hall. It covers the development of architectural and structural plans while giving importance to safety, accessibility, and practical use.

The proposed hall is intended to serve different functions, such as providing shelter and support during disasters, hosting government programs and public meetings, and serving as a venue for health services, livelihood training, youth activities, and cultural events. The study also looks at how this facility can help improve disaster readiness, strengthen local programs, and offer the people of Norzagaray a secure and dependable space for community needs,

This study is concerned only with the planning and design of the proposed multipurpose hall. It does not include the actual construction process, the detailed budgeting, or the purchase of materials, although approximate cost estimates may be provided to support the proposal.

The research is focused on the situation of Norzagaray, Bulacan, and the findings may not fully apply to other towns that have different conditions and community needs. Factors such as the availability of funds, approval from authorities, and unexpected environmental issues are also outside the coverage of this study.

Definition of terms

The following terms are theoretically defined for a better understanding of the present research study.

Architectural Plan - a plan that shows the layout of a planned building, including the floor design, front and side views, and cross-sections.

Community - A group of individuals who share a common location, interest, identity, or purpose, and who interact with one another through social, cultural, or cooperative

Conserve - To protect and manage resources responsibly in order to prevent loss, waste, or depletion, ensuring their availability and sustainability over time.

Energy Consumption - The amount of energy used by systems, devices, or activities to perform functions or produce outcomes, typically measured over a specific period of time.

Facility - An establishment designed to support specific activities through organized spaces and services. The proposed hall acts as a facility intended to serve multiple community functions while demonstrating sustainable architectural solutions.

Integrate - To bring together different components into a functioning system. Within the research, the concept focuses on merging rainwater harvesting and passive ventilation elements into a unified building design.

Passive Ventilation - The method of bringing fresh air in and letting stale air out of a room without using machines or equipment.

Rainwater Harvesting - the collection and storage of rainwater, rather than allowing it to run off.

Structural Plan - drawings that show load-bearing members and materials for a building.

Sustainable Design - aims to lessen harm to the environment and protect the health and comfort of the people using the building, while also improving how the building works.

Thermal Comfort - A condition in which occupants experience a balanced temperature and airflow conducive to comfort

CHAPTER 2

Review of Related Literature and Study

This chapter presents a review of related literature and studies, following a thorough search conducted by local and foreign researchers.

Foreign Literature

The following literature was reviewed to enrich this study and to serve as the basis for the researchers' approach to the current study.

Passive Cooling Strategies for Sustainable Buildings

While the heat index is gradually increasing due to climate change and growing urbanization, it affects daily lives and escalates the consumption of energy as a result of longer usage of air conditioning units. The MoEF&CC (2024) has formulated strategies aimed at reducing cooling demand by 20-25%, but at the same time, provide equal comfort. The three core strategies are heat protection, heat modulation, and heat dissipation.

Heat protection. This process is to prevent heat entry through different methods. First is building orientation. This prioritizes minimizing direct sun exposure and maximizing natural ventilation. Second is landscaping.

Integrating natural elements not only for aesthetics, but also to create shade for the building. Third is shading devices. This protects interior spaces from direct sunlight and allows effective use of natural light.

Heat modulation. Using insulators, phase change materials (PCMs), and trombe walls to control heat absorption of the building.

Heat dissipation. To release excess heat via natural ventilation, radiative cooling, and evaporative cooling.

By integrating these methods, we can respond to the local climate conditions to reduce heat impact and cooling demand. Also, this can serve as an example of why these strategies should be applied actively in building designs.

Strategic Design and Finance of Rainwater Harvesting to Cost-Effectively Meet Large-Scale Urban Water Infrastructure Needs, (2020)

Many cities struggle with water scarcity issues, while stormwater runoff causes urban flooding. This literature identifies rooftop rainwater harvesting (RWH) as a scalable, decentralized, cost-effective approach to ease shortages and reduce runoff.

According to van Dijk, Lounsbury, Hoekstra, and Wang (2020), the study, Strategic design and finance of rainwater harvesting to cost-effectively meet large-scale urban water infrastructure needs, shows that rooftop rainwater harvesting, when planned and financed strategically, can supply non-potable water and lessen stormwater burdens in a city. Contrary to the usual idea that RWH is too small or too costly, they argue that its *multi-functionality and adaptability* are the real levers of system value. Unlike existing urban water infrastructures that are centralized and have

a single purpose, RWH operates as a decentralized, multifunctional system that provides water supplies, substitutes the water that is intended for drinking but is used for non-drinking purposes, and reduces stormwater runoff, which is a major source of flooding and water pollution in cities worldwide (Campisano et al., 2017). Considering its conceptual contributions, the study emphasizes that the placement of RWH being in the rooftop, when planned well and is built to a location where it is most needed, instead of being placed randomly, can help the city by adding extra water sources and can reduce flooding.

Anchored by this literature of van Dijk, Lounsbury, Hoekstra, and Wang (2020), the evidence indicates that rooftop rainwater harvesting can function as a cost-effective city-scale solution when it is planned and financed strategically, providing a dependable non-potable supply while cutting stormwater peaks, which aligns with broader findings in Campisano et al. (2017). The arguments given are relevant to the current study as the Multi-purpose hall concentrates on predictable non-potable demands such as toilet flushing, equipment wash-down and general outdoor cleaning, making it an ideal high-impact node for targeted deployment. The hall can substitute potable water where it is not needed, reduce runoff from its roof area, and improve resilience in a community. This literature provides a strong conceptual foundation that supports the current study on adapting rainwater harvesting on a sustainable multipurpose hall with passive ventilation located in Barangay Poblacion, Norzagaray, Bulacan.

Impact of Material Solutions and a Passive Sports Hall's Use on Thermal Comfort, (2023)

According to Pavlovska, Kisilewicz, and Mikulski (2023), maintaining thermal comfort in buildings depends on how the passive ventilation strategies is used and not just about construction materials. Their study emphasizes that even if the type of wall material is relevant to the performance of a building, the incorporation of night-time ventilation, natural ventilation, plays an

important role in preventing overheating and ensuring balanced indoor temperatures. The study highlighted that passive ventilation when combined with thermal capacity of a building's structure, it improves comfort by allowing the building to store and release heat naturally. This finding points out the importance of using passive design solutions such as proper ventilation and material optimization in achieving sustainable and comfortable indoor environment.

The study provides a solid conceptual foundation that will support the current study, the design of sustainable multipurpose hall, it is integrated with passive ventilation focused on creating a structure that minimizes energy consumption while ensuring the comfort of the user. Moreover, the study highlights the importance of passive design strategies emphasizing that even though the choice of wall materials is important to the performance of building, the integration of night-time ventilation, particularly natural ventilation, plays a vital role in preventing overheating and maintaining balanced indoor temperatures. Thus, this insight is highly relevant and contributes significantly to the current study.

Integrating Natural Lighting for Sustainable Building Design

According to GS Odiyur Vathanam et al, (2021), "A review on effective use of daylight harvesting using intelligent lighting control systems for sustainable office buildings in India", lighting is one of the most fundamental requirements in modern life, and the advancement of daylight harvesting has become an urgent necessity. Daylight, being universally available and clean, offers an environmentally friendly and cost-efficient energy source for buildings. Studies emphasize that controlling artificial lighting in response to available daylight allows spaces to maintain required illumination levels while conserving energy. In addition to reducing energy consumption, daylight harvesting also aligns with the global Sustainable Development Goals by supporting more sustainable urban development practices. This perspective shows that the technology provides both environmental and social benefits when effectively applied in architectural design.

The study further explains that daylight harvesting is no longer focused solely on energy savings but also considers cost efficiency, user comfort, and uniform illumination. By simulating daylight contributions in office buildings using ECO TECH software, researchers were able to test factors such as building orientation and surface reflectance to predict actual daylight penetration. The results demonstrated that architectural design decisions, including ceiling, wall, and floor reflectance, have a direct effect on meeting daylighting standards prescribed by green building councils. Such simulations provide valuable insight into how predictive technologies can

optimize energy use before construction begins. This indicates that daylight harvesting is as much about design foresight as it is about technology integration.

The findings are relevant to the present study because multipurpose halls, like those in Norzagaray, share similar requirements for large, well-lit spaces that consume significant amounts of electricity. Applying daylight harvesting principles could reduce reliance on artificial lighting and lower operational costs, making the hall more sustainable for the community. Moreover, considering user comfort, uniform lighting, and strategic orientation at the design stage ensures that the facility serves its purpose effectively without unnecessary energy expenditure. The use of simulation tools and predictive modeling could also guide the design of the hall to maximize natural light. Therefore, integrating daylight harvesting strategies in the multipurpose hall is both practical and consistent with sustainable community development goals.

Rainwater Harvesting and Treatment: State of the Art and Perspectives

According to Raimondi A. et al, (2023), “Rainwater harvesting and treatment: State of the art and perspectives.” rainwater harvesting has been used for many years to deal with floods and droughts. It is seen as a sustainable way to manage water while also providing social and environmental benefits that align with the Sustainable Development Goals. The review explains that using rainwater reduces the demand for potable water and helps conserve resources in both rural and urban areas. These insights are valuable in the design of buildings that aim to lessen their environmental footprint. For this reason, rainwater harvesting is an important feature in creating sustainable community facilities.

The review also highlights that the performance of rainwater systems depends on design factors such as scale, treatment process, and local conditions. Advanced treatment technologies, including physical and biological methods, are still developing but show potential for safer reuse of rainwater. This connects well to the proposed multipurpose hall, which can benefit from an efficient and properly designed harvesting system. By adapting these methods, the building can provide water for non-potable uses such as cleaning and toilet flushing. This not only saves potable water but also supports resilience during times of water shortage.

In the context of Barangay Poblacion, Norzagaray, these findings support the goal of designing a multipurpose hall that is both practical and sustainable. The hall can integrate rainwater harvesting as part of its system while also using passive ventilation to lessen energy demand. Together, these features address the need for cost-efficient, eco-friendly infrastructure in the community. Linking existing literature to the local setting strengthens the proposal by showing that the design is backed by proven methods and technologies. In this way, the study applies global knowledge to create solutions for local community needs.

Local Literature

Rainwater harvesting for enhancing upland agriculture: Lessons and experiences in selected upland farming communities in Albay Province, Philippines, (2022)

According to Landicho et al. (2022), “Rainwater harvesting for enhancing upland agriculture: Lessons and experiences in selected upland farming communities in Albay Province, Philippines.” upland farming communities in Albay Province face serious problems with water scarcity due to climate change, rainfed agriculture, and poor soil conditions. To respond, rainwater harvesting facilities (RWHFs) were built in partnership with state universities, local governments, and farmer groups. These projects showed that with collective effort, communities can better manage water resources and reduce vulnerability to environmental stress. The study also highlighted the role of proper training, collaboration, and resource-sharing in sustaining the facilities. This shows that rainwater harvesting is not only a technical solution but also a community-driven initiative.

In relation to the proposed sustainable multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan, the findings of Landicho et al. support the idea of using rainwater harvesting as part of building design. While their study focused on farming communities, both works emphasize the importance of local adaptation to water scarcity. The Albay experience proves that rainwater harvesting can be applied successfully in different settings if guided by planning and community involvement. Likewise, the multipurpose hall aims to lessen dependence on potable water supply by using collected rainwater for non-potable purposes. This creates a direct link between sustainable building practices and climate adaptation strategies.

Furthermore, the integration of rainwater harvesting with passive cooling systems in the proposed multipurpose hall strengthens the relevance of Landicho et

al.'s study. Both works share the goal of promoting sustainability by reduce resource consumption and adapting to environmental challenges. The lessons learned in Albay about collaboration, maintenance, and long-term planning can also be applied to public buildings like the multipurpose hall. Designing infrastructure that considers climate realities makes it more resilient and community-focused. In this way, the proposed hall can serve as a model for sustainable development projects in other parts of the Philippines.

Rainwater Harvesting Practices and Utilization in the Island of Malangabang, Philippines, (2022)

According to JA Ciriaco et al. (2022), "Rainwater Harvesting Practices and Utilization in the Island of Malangabang, Philippines.", rainwater harvesting in Malangabang Island is mainly collected from rooftops and used for domestic purposes such as watering plants, cleaning, and toilet flushing. The study showed that excess rainwater from grounds and other surfaces is less utilized, highlighting inefficiencies in capturing and storing rainfall. Residents adapted their harvesting practices to meet household needs, demonstrating how local communities respond to limited water supply. These findings suggest that even small-scale rainwater collection can significantly support daily water requirements in areas with scarce water resources. This emphasizes the need for properly designed and functional rainwater systems to maximize water utilization.

The study also revealed that harvested rainwater can be used for multiple purposes, including personal washing, cooking, and irrigation, depending on

collection and storage practices. JA Ciriaco et al. (2021) pointed out that proper planning of rainwater infrastructure could improve efficiency and accessibility for the community. This aligns with the goals of sustainable building design, where water conservation and alternative water sources are integrated into the structure. Implementing rainwater harvesting systems in public buildings like multipurpose halls can reduce dependence on the municipal water supply. Such integration can also provide a practical solution to water scarcity while promoting environmental sustainability.

Moreover, this research supports the broader concept of sustainable design, emphasizing that community water needs can be met through local solutions. For a multipurpose hall in Barangay Poblacion, Norzagaray, incorporating rainwater harvesting systems can ensure a reliable water source for various functions. It also complements passive design strategies, such as natural ventilation, to reduce energy consumption and enhance comfort. The findings demonstrate that planning for water sustainability is not only environmentally responsible but also socially beneficial. Overall, adopting rainwater harvesting systems in public buildings reflects a practical and context-sensitive approach to sustainable architecture.

Issues, challenges, and strategies for the implementation of roof-based rainwater harvesting systems in the Philippines, (2023)

According to Lumbera et al, (2023) entitled “Issues, challenges, and strategies for the implementation of roof-based rainwater harvesting systems in the Philippines”, the Philippines receives abundant rainfall ranging from 960 to 4000 mm annually, yet

water scarcity remains a looming concern, especially during extended dry seasons. Rainwater harvesting (RWH) is identified as a practical alternative source, where rainwater is collected, stored, and treated for on-site applications. Despite its potential, the literature points out that there is limited local research and no clear standards to guide the design, construction, and maintenance of RWH systems in the country. These gaps in knowledge hinder the widespread use of RWH, even though rainfall is readily available. The situation reveals a need for both scientific studies and policy frameworks tailored to Philippine conditions.

The study also highlights challenges that restrict the adoption of rainwater harvesting at the community level. Lack of public awareness remains a significant obstacle, as many households are not familiar with the technology or its benefits. Furthermore, the absence of hydrological data complicates planning and design, while socioeconomic factors such as land tenure issues and unemployment discourage investment in RWH systems. To overcome these barriers, recommendations include education campaigns, financial subsidies, and tax incentives that would make the technology more accessible. The integration of GIS-based planning is also suggested to improve site-specific system design.

The findings are highly relevant to the current study, which seeks to integrate sustainable water management in the design of a multipurpose hall in Norzagaray, Bulacan. Given the area's exposure to heavy rainfall, adopting an RWH system can reduce reliance on municipal water supplies and lower operational costs. At the same time, addressing awareness and design challenges can serve as a model for other local

government projects that aim to maximize natural resources. Incorporating RWH aligns with both environmental sustainability and community resilience by ensuring water availability even during dry periods. Thus, the lessons from this literature provide a valuable foundation for applying practical and context-sensitive water solutions in the proposed hall.

Stormwater harvesting from roof catchments: A review of design, efficiency, and sustainability, (2023)

According to Bañas et al, (2023), "Stormwater harvesting from roof catchments: A review of design, efficiency, and sustainability", rainwater harvesting systems (RWHS) are becoming an important option for addressing water scarcity in buildings. Their review explained that roof runoff can be collected and used for different non-potable purposes, which may help reduce dependence on centralized water supply. They pointed out that the quality of harvested water depends on the roof material and treatment process applied. The study also emphasized that evaluating the location and user acceptance is vital in making the system efficient. In addition, financial factors such as return on investment should be considered when planning for RWHS in community structures.

These findings are significant to the present research on the sustainable design of a multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan. Since the proposed hall includes a rainwater harvesting system, the insights on water quality and treatment methods can guide the selection of filtration and storage facilities. The emphasis on economic feasibility also supports the need to design a system that is both

cost-effective and environmentally sound. This ensures that the harvested water can be used safely for purposes such as cleaning, flushing, or landscape irrigation. In this way, the multipurpose hall can serve as a model for sustainable infrastructure in local communities.

Moreover, the review aligns with the study's aim to integrate both rainwater harvesting and passive ventilation in one building design. By highlighting sustainability in terms of environmental, social, and financial aspects, Bañas et al. provide a framework for assessing the long-term benefits of the proposed hall. Their review confirms that sustainability is not limited to technical performance but also to the acceptance of end users. Applying these lessons to the multipurpose hall project may help ensure that the facility is functional, energy-efficient, and well-received by the community. Thus, the integration of rainwater harvesting and passive ventilation systems strengthens the overall goal of promoting sustainable design in local development.

A Review on Phase-Changing Materials Applications in Energy-Efficient Building Envelope Designs, (2024)

According to SU Mina and R Garcia-Tayactac (2024) entitled "A Review on Phase-Changing Materials Applications in Energy-Efficient Building Envelope Designs", HVAC systems have been used for over a century to make buildings comfortable by controlling temperature. However, these systems use a lot of energy and create high thermal loads in buildings. To help save energy, researchers are looking at ways to improve building materials so they can store and release heat naturally. One

method is using Phase Change Materials (PCMs), which can absorb heat when it's hot and release it when it's cooler. This helps keep indoor temperatures stable without relying too much on air conditioning or heating.

PCMs have special properties that make them better at controlling heat than regular building materials. Research shows that adding PCMs to walls, ceilings, or floors can lower the heat entering a building by about 25% each year. Different types of PCMs and ways to put them into building materials have been studied to get the best results. Using PCMs helps buildings stay cooler in hot weather and warmer in cool weather, reducing energy use. This makes them a simple, passive and effective way to improve energy efficiency.

This is useful for designing the multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan. Adding PCMs to the hall's walls or ceilings can reduce the need for mechanical cooling. It also works together with passive ventilation to make the hall more comfortable while saving energy. Using PCMs is an easy way to create a sustainable, energy-efficient space that suits the tropical climate of the area.

Foreign Studies

There are just a few studies that are closely linked with the current study's central idea. Having said that, the researchers used papers with a different primary phenomenon but related conclusions.

The effects of passive design on indoor thermal comfort and energy savings for residential buildings in hot climates: A systematic review, (2023)

According to Hu et al. (2023), passive design strategies improve indoor thermal comfort and reduce energy consumption in residential buildings located in hot climates. This review synthesizes findings from multiple studies to identify the most effective techniques and their performance outcomes.

Design Considerations for Hot Climates. To design residential buildings in hot climates, passive strategies must be customized to the local environment**.** Designers must study local weather patterns like temperature, humidity, and wind patterns to choose the right passive techniques.

Thermal comfort. A passive system enhances air movement and humidity control, thereby reducing overheating and contributing to occupants' overall comfort. Studies show that a well-designed passive system can maintain indoor temperatures within an acceptable comfort range, even during peak heat.

Energy savings. Low reliance on air conditioning units leads to cost savings and reduced carbon emissions.

These findings are relevant to the current study to have a comparative insights from similar climate zone and to provide scientific backing for our passive ventilation system. This way, we can evaluate the thermal comfort and energy saving of our design and make our design approach more effectively.

Alternative Ways of Cooling a Passive School Building in Order to Maintain Thermal Comfort in Summer

Dudzińska and Kisilewicz (2021), in their study entitled Alternative Ways of

Cooling a Passive School Building in Order to Maintain Thermal Comfort in Summer published in Energies 14(1), explored various passive cooling strategies for educational buildings designed under the passive-house standard. Through simulation using DesignBuilder, they tested night ventilation and mechanical ventilation with and without a ground heat exchanger to assess indoor temperature control. The findings revealed that natural night ventilation, when properly designed, could maintain indoor comfort without mechanical air conditioning, thereby reducing operational energy consumption.

This study is highly relevant to the present research on the design of a sustainable multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan, as both works emphasize the use of passive ventilation to achieve thermal comfort and sustainability. In the Philippines, where high temperatures and humidity persist year-round, integrating similar passive cooling strategies can reduce the building's reliance on artificial ventilation systems. Applying Dudzińska and Kisilewicz's findings supports the proposed hall's goal to maintain comfortable indoor conditions while minimizing energy costs and environmental impact.

The investigation of Dudzińska and Kisilewicz (2021) supports the present research by demonstrating that natural airflow and passive cooling can significantly reduce indoor heat and energy consumption. Their work provides design insights that can be applied to the proposed multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan, particularly in planning openings and building orientation. These findings strengthen the idea that thermal comfort can be achieved through Passive Design

Theory, which guides the sustainable ventilation strategy of the current study.

Analysis of Impact of Natural Ventilation Strategies in Ventilation Rates and Indoor Environmental Acoustics Using Sensor Measurement Data in Educational Buildings

De la Hoz-Torres, M. L., Aguilar-Aguilera, A. J., Ruiz, D. P., and Martínez-Aires, M. D. (2021) conducted a study titled Analysis of Impact of Natural Ventilation Strategies in Ventilation Rates and Indoor Environmental Acoustics Using Sensor Measurement Data in Educational Buildings published in Sensors 21(18). The research analyzed natural ventilation performance in classrooms at the University of Granada, Spain, by measuring carbon-dioxide concentration and acoustic levels under different window and door configurations. Results showed air-exchange rates between 3.7 and 39.8 air changes per hour (ACH), indicating that ventilation effectiveness depends on the layout and opening strategy. However, higher ventilation rates were associated with increased noise levels, demonstrating the need to balance air quality, thermal comfort, and acoustic comfort.

For the proposed multipurpose hall in Norzagaray, these findings highlight the importance of designing natural ventilation that not only provides sufficient airflow but also maintains acceptable acoustic conditions for community gatherings, meetings, and emergency shelter use. The research underscores the value of cross-ventilation, appropriate window placement, and airflow direction in enhancing comfort for large, open community structures such as the multipurpose hall envisioned in this study.

The work of de la Hoz-Torres and colleagues (2021) emphasizes the importance

of designing window layouts and openings that balance airflow and acoustic comfort. Their findings are closely related to the current research, as they provide a scientific basis for incorporating natural ventilation into the proposed multipurpose hall. By applying these strategies, the researchers can design a structure that promotes indoor comfort, energy efficiency, and environmental sustainability reflecting the core principles of Sustainable Development Theory used in this study.

Modelling the Potential of Rainwater Harvesting to Improve Resilience to Drought in Urban Parks

Jacque et al. (2023), in their article Modelling the Potential of Rainwater Harvesting to Improve Resilience to Drought in Urban Parks published in the Journal of Environmental Management, assessed how rainwater-harvesting (RWH) systems can enhance resilience and reduce dependence on potable water in urban environments. Using simulation modeling, they evaluated storage capacities, rainfall patterns, and irrigation demands to determine system efficiency. Results showed that RWH significantly contributes to water self-sufficiency and drought resilience, especially when storage volume and catchment area are optimized. The study also identified that maintenance and climate variability influence long-term performance.

These insights directly support the present research, which incorporates a rainwater-harvesting system into the multipurpose hall design. Just as urban parks rely on rainfall collection for irrigation, the proposed hall can utilize stored rainwater for non-potable uses such as toilet flushing, landscape irrigation, and cleaning. Jacque et

al.'s findings provide a scientific basis for determining appropriate storage sizing, catchment planning, and seasonal utilization in the hall's design, thereby improving resource efficiency and ensuring water availability even during dry seasons in Norzagaray.

The study conducted by Jacque et al. (2023) is relevant to the ongoing research because it provides valuable insights into the design and effectiveness of rainwater harvesting systems. Their findings serve as a reference for integrating water collection and storage systems into the proposed multipurpose hall in Barangay Poblacion. This connection supports the Water Conservation Theory, as both studies emphasize sustainable water use and resource management to enhance community resilience.

Impact of Material Solutions and a Passive Sports Hall's Use on Thermal Comfort, (2023)

According to Dudzińska et al. (2023), material solutions and passive design significantly enhance thermal comfort in a sports hall. Integrating high thermal capacity materials and passive design strategies reduces energy consumption in large public buildings like sports halls, which often face high thermal loads due to large volumes, active use, and limited insulation. The study focuses on the role of thermal mass**,** night ventilation**,** and occupancy patterns in maintaining a comfortable indoor experience without relying on mechanical cooling systems.

Material solution and thermal mass. Heavyweight materials like concrete and brick have a high thermal capacity. This allows them to absorb heat during the

day and release it at night. Compared to lightweight materials that respond quickly to temperature changes but offer less resistance to heat.

Passive ventilation strategies. The sports hall uses night-time ventilation to cool the designed building. During the day, the building absorbs heat from people, sunlight, and equipment. This gets trapped inside mainly because of the high thermal mass walls. Instead of using air conditioning, night-time ventilation allows cooler outdoor air to enter the building after sunset, when temperatures drop.

Impact of usage patterns. Proper scheduling of ventilation and material selection can optimize comfort during the time of usage of the hall. Passive strategies must be adapted to match usage timing, especially in buildings with high metabolic activity.

This findings are highly related to our study because of the similar building type and function. Both studies focus on large public-use buildings—a sports hall and a multipurpose hall—where indoor comfort is essential for community activities. The findings about thermal comfort in a sports hall directly inform how to design a multipurpose hall that accommodates gatherings, events, and active use.

Local Studies

Proposed Multi-Purpose Hall in De La Paz Elementary School, Lubao, Pampanga, (2023)

According to Manansala et al. (2023), the De La Paz Elementary School and the barangay have been suffering from a lack of key infrastructure, such as a proper stage, court, clinic, and standard court. The situation forced the events and activities to be held in hallways and exposed areas. In response to this state, the researcher proposed a multipurpose hall that is designed to serve both school and the community. The study emphasized that the elevated design and partitioned interior allow the building to function as a temporary shelter during calamities, highlighting its purpose and validating its structural integrity by performing structural frame analysis using STAAD Pro and verifying member capacity through manual computation.

The study is relevant to the current research as it demonstrates the community's need for an accessible multipurpose hall that will support educational and social activities. However, while the study is focused on the structural requirements of the hall, it did not involve sustainability concepts. This creates a gap wherein the current research aims to address in Barangay Poblacion, Norzagaray, Bulacan, by designing a sustainable multipurpose hall incorporating a rainwater harvesting system and passive ventilation.

Water Shortage: Rainwater Harvesting System Design in Busay Barangay Hall, Cebu City, (2022)

A local study conducted in Barangay Busay is focused on addressing the water scarcity issue through the design of a rainwater harvesting system. The researchers gathered data using photo documentation, document analysis, and interviews with Barangay personnel to evaluate the current water situation. Based on the findings that

were collected it revealed that the Barangay Hall relied on weekly water truck deliveries for non-potable water, which was used mostly for toilet flushing, gardening, and dishwashing. To reduce this shortage, the study proposed the implementation of an RWH system for the Barangay Health Center, which serves 13 personnel. The researchers used STAAD Pro v. 8 design software to develop a structural design with appropriate and safe steel sections of HSSP6x0.5 for columns, L40x40x10 for the tank base, and L25x25x5 for the remaining frame. And to ensure the efficiency of water flow within the facility, a one-horsepower pump and a gravitational distribution were incorporated into the system.

This study validates the current research by showing how a rainwater harvesting system can function effectively even without filtration since the water that will be collected is intended for non-potable use, such as flushing the toilet, water gardening, and other non-health use of water, aligning with the current research's goal. The size of the water tank and the one-horsepower pump in their design offers a helpful reference on how to determine suitable equipment capacity and water distribution methods for the current study. In adapting RWH, the idea of integrating a robust pre-storage filter or first flush diverter that was mentioned in the study will also be considered to improve the water quality by preventing debris and other contaminants from entering the tank.

Simulation-Based Design of a Sustainable Multi-purpose Academic Building in the Philippines: A Case Study at EVSU-LUNA Campus, (2025)

According to the study, “Simulation-Based Design of a Sustainable Multipurpose Academic Building in the Philippines: A case study at EVSU-LUNA CAMPUS”, the researchers collected data through the use of simulation-based methods such as Autodesk CFD 2026, REVIT Solar Analysis, HOMER Pro, and STAAD.Pro to evaluate passive cooling strategies, renewable energy integration, and structural compliance with the National Building Code of the Philippines. Based on findings, it revealed that the proposed design successfully reduced indoor air temperatures by 5–6 °C compared to typical Philippine school buildings, while cross-ventilation and awning window designs enhanced air velocity up to 2.5 m/s, improving thermal comfort. Additionally, a 2.9 kW PV–grid–battery hybrid solar energy system was also used, which helps to achieve a 24% renewable energy fraction and reduce the Levelized Cost of Energy from $0.62/kWh to $0.46/kWh. Daylighting simulations also showed that 75% of occupied areas could operate without artificial lighting during peak hours. In addition, its structural analysis confirmed compliance with the national building codes. Collectively, the results that have been stated prove that sustainable, simulation-based design can provide comfort, improve energy performance, and be cost-effective.

This study is highly beneficial to the proposed sustainable multipurpose hall, which is integrated with passive ventilation. The gathered data on passive cooling, cross ventilation, and solar energy resources directly support the objectives of the current study by showing that natural airflow can reduce indoor temperatures while using less energy, meanwhile, the solar energy serves as a renewable energy system,

which can reduce dependence on non-renewable power sources. The simulation-based methods that have been used in the study also provide a practical reference in evaluating building performance, which can also be applied in the optimization of ventilation and lighting in the current study.

A Study on the Application of Integrated Ventilation Strategies Based on Wind Simulation and Solar Radiation Analysis in Low-Rise Residential Buildings in Manila, (2025)

Based on Mendoza & Lantigua (2025), in a study on the application of integrated ventilation strategies based on wind simulation and solar radiation analysis in low-rise residential buildings in Manila. An investigation was conducted to test passive ventilation strategies by employing computational fluid dynamics and solar radiation mapping. The researcher studied how the building orientation, form, shading design, and material selection can be optimized to reduce heat accumulation and have better natural airflow. Findings showed that the combination of passive design strategies improved air change by up to 250% and lowered indoor temperature by over 4 degrees Celsius, which proves that it can enhance thermal comfort without relying on mechanical cooling.

The approach used in this study is highly beneficial as it demonstrates how effective it is to integrate wind simulation and solar radiation to achieve a passive ventilation in which to be adapted in the current study, a sustainable multipurpose hall located in Barangay Poblacion, Norzagaray, Bulacan. Through CFD modeling, the current study can analyze how air circulates, which gives an advantage in identifying

window placement, openings, and orientation for better airflow. Meanwhile, solar radiation mapping can help to determine which area receives the most heat, allowing adjustment in wall orientation, window placement, and shading devices. Adopting these methods to the design of a multipurpose hall can produce a place that is naturally cooler, better ventilated, and is energy efficient, aligning with sustainable building principles.

Investigating Diffuse Pollution Dynamics in an Urban Catchment Area Using First Flush Analysis, (2020)

A local study conducted by Cruz, G. et al. (2020), investigated the diffuse pollution dynamics by analyzing the occurrence of the first flush of urban stormwater runoff from actual rainfall events in Balanga City, Bataan, Philippines, and used it as an evidence-based criterion to design low-impact development controls. Based on the gathered data from actual rainfall events, and tested them to check the quality of water. The study identifies that the first 10% to 30% of runoff during storm events with an average rainfall intensity of 5mm/hr, hence, findings led to the recommendation that at least 30% of the runoff should be subject to treatment. Results of this study provide a localized framework for designing and implementing options for robust urban water management, especially in designing appropriate LID controls that will address non-point source pollution in developing countries like the Philippines.

This study emphasized a different aspect that the current study should focus on. By applying the findings with regard to the first flush phenomenon, the proposed multipurpose hall integrated with a rainwater harvesting system can find a way to

divert or treat the first 30% of runoff before storing to ensure that the water collected will meet the acceptable quality standards for non-potable uses. Thus, the study demonstrates the feasibility of integrating stormwater management strategies into urban developments.

Synthesis of Related Literature and Study

The reviewed literature and studies provide evidence of the effectiveness of natural airflow and thermal mass in maintaining indoor temperature while reducing energy consumption. This collectively supports the integration of passive cooling strategies in sustainable public infrastructure, particularly in hot and humid climates like the Philippines, specifically in Norzagaray.

Meanwhile, studies related to rainwater harvesting systems demonstrates the effectiveness for addressing water scarcity and reducing reliance on municipal supply. These works explore design efficiency, cost-effectiveness, and community engagement, offering practical insights for implementing roof-based systems in barangay settings. Together, these findings provides validation of the use of passive ventilation and rainwater harvesting as sustainable, climate-responsive solutions for the proposed multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan.

CHAPTER 3

Research Methodology

This chapter concentrates on the discussion of the research method and procedures adhered to by the researcher to answer systematically the study of experimental research. Specifically, the research design, respondents of the study, sampling techniques, instruments used, and the statistical treatment of data used for accurate data analysis and interpretation were explained in this chapter.

Research Design

This study will use a descriptive quantitative and experimental quantitative research design to collect data, analyze community needs, and test the performance of sustainable systems to be integrated into the proposed multipurpose hall in Barangay Poblacion, Norzagaray, Bulacan.

The descriptive quantitative design will be used to describe the existing conditions of the community and to identify the need for a multipurpose hall. The researchers will gather data through surveys, informal interviews, and site observations. These methods will help determine the frequency of community activities, common concerns, and the environmental factors affecting the proposed site.

The experimental quantitative design will be used to test and compare the performance of the proposed sustainable systems—specifically, the passive ventilation

and rainwater harvesting systems. The researchers will conduct simulations and calculations to measure air temperature, airflow, and potential rainwater collection. The independent variables will be the sustainable systems applied, while the dependent variables will be the indoor comfort level and collected water volume.

By combining descriptive and experimental methods, the researchers aim to understand the community's actual conditions and scientifically evaluate how the proposed sustainable design can address those needs. This design will help ensure that the final output is functional, efficient, and appropriate for the residents of Barangay Poblacion.

Sample and Population

The population of this study will consist of the residents of Barangay Poblacion, Norzagaray, Bulacan, as they are the primary users and beneficiaries of the proposed multipurpose hall. Barangay officials will also be included to provide information on community activities and existing facilities.

For the descriptive quantitative part, the researchers will select respondents from different zones of Barangay Poblacion to ensure that the data represent the entire community. The population of the barangay will serve as the sampling frame, while the sample size will be determined using the Slovin's formula with a 5% margin of error to obtain a reliable number of participants. The purposive sampling technique

will be used since the study targets residents who have knowledge of or involvement in community events and gatherings.

Sample Size Determination

The total population of the study will be based on the number of households in Barangay Poblacion, Norzagaray, Bulacan. According to the latest record from the Barangay Office. There are [number] households in the barangay.

To determine the appropriate sample size, Slovin's formula will be used:

$$n = \frac{N}{1 + N(e)^2}$$

Where:

- n = sample size
- N = total population (number of households in Barangay Poblacion)
- e = margin of error (0.05 or 5%)

Research Instrument

To collect the necessary data, the researchers will use both survey instruments and technical tools suited for the descriptive and experimental parts of the study.

Survey Questionnaire

A structured questionnaire will be developed and distributed to selected residents of Barangay Poblacion. It will gather numerical data about their demographics, frequency of community activities, and opinions about the need for a multipurpose hall. It will also include questions about their awareness and views on sustainable design features such as passive ventilation and rainwater harvesting. The responses will use a Likert scale to make results easy to analyze statistically.

Informal Interview Guide

Informal interviews will be conducted with barangay officials and residents to gain deeper insights into community concerns, environmental issues, and suggestions for the proposed hall. This will support and validate the survey results.

Site Observation Checklist

The researchers will personally visit the proposed site to record environmental factors such as wind direction, sunlight exposure, drainage condition, and accessibility. These observations will help in planning the building's orientation and layout.

Technical Simulation Tools

For the experimental part, the researchers will use computer-aided design tools such as AutoCAD, STAAD, SketchUp, and Autodesk CFD (Computational Fluid

Dynamics). These tools will simulate air movement and temperature to test the performance of the passive ventilation system.

Rainwater Harvesting Computation Sheet

A spreadsheet computation tool will be used to estimate the volume of rainwater that can be collected from the roof area using local rainfall data. This will determine the efficiency of the rainwater harvesting system.

Cost Estimation Worksheet

The researchers will also prepare a cost estimation sheet to calculate the approximate construction expenses for the proposed design, including materials and sustainable components.

These instruments will provide both numerical and descriptive data, helping the researchers produce a sustainable design that is technically sound, practical, and responsive to community needs.

Data Gathering Procedure

The study will gather data through three main components: design and modeling, survey, and costing.

For the **design and modeling**, site data such as measurements, roof dimensions, and surrounding environmental conditions will first be gathered through an on-site visit and proper documentation. The collected information will then be used to develop 2D plans in AutoCAD and 3D models in SketchUp to present the overall layout, including the rainwater harvesting and passive ventilation systems. A simple water filtration design will also be incorporated into the rainwater harvesting setup to ensure the collected water is clean and safe for non-potable uses. Structural analysis will be conducted in STAAD to confirm that all components, including the storage tank and filtration unit, are stable and secure. These outputs will serve as the basis for visualizing the proposed sustainable design and evaluating its overall efficiency.

For the **survey**, questionnaires will be distributed to selected community members, barangay officials, and frequent users of the multipurpose hall to gather insights about their water usage, comfort levels, and perceptions of sustainability features. The survey will include both closed-ended and open-ended questions to collect quantitative and qualitative data, providing valuable feedback that will guide the design's practicality and community acceptance.

For the **costing**, a detailed bill of materials will be prepared based on the final design. Market surveys and supplier quotations will be gathered to estimate the prices of materials, equipment, and labor related to the rainwater harvesting and ventilation systems. The total project cost will then be computed, including contingency and indirect expenses, to determine the economic feasibility of the proposed sustainable design.

Statistical Treatment

Statistics is a type of analysis that involves using different types of statistical tools to analyze and understand the outcome of the data that is presented in a certain study. The researchers used the statistical tool below as it was seen fit to use.

Frequency and Percentage

The data gathered from the respondents' demographic profile, such as age, gender, and length of residency, were analyzed using frequency and percentage. Frequency was used to show how many respondents belong to each category, while percentage was used to show the portion of each group compared to the total number of respondents. These tools helped the researchers describe the characteristics of the participants in a simple and clear way.

Likert Scale and Weighted Mean

The data gathered from the survey about the design features of the proposed multipurpose hall were analyzed using a Likert scale and weighted mean. The Likert scale was used to measure the level of agreement of the respondents with each statement. The weighted mean was used to get the average score for each item. This helped the researchers find out the overall opinion of the respondents about the effectiveness, comfort, and sustainability of the proposed design.

Rate	Verbal Interpretation	Range

5	Strongly Agree	4.21-5.00
4	Agree	3.41-4.20
3	Neutral	2.61-3.40
2	Disagree	1.81-2.60
1	Strongly Disagree	1.00-1.80

Table 2: Likert Scale

Formula:

$$Weighted\ Mean\ = \frac{\sum(f\ \times w)}{Total\ Response}$$

Where:

f = frequency of each response

w = weight assigned to each response

A Sustainable Design of a Multipurpose Hall with Rainwater Harvesting System and a Passive Ventilation System in Barangay Poblacion, Norzagaray, Bulacan

This survey is part of a research study aimed at understanding community needs and preferences for the design of a sustainable multipurpose hall in Barangay Poblacion. Your responses will remain confidential and will be used solely for academic purposes. The survey will take approximately 5–10 minutes to complete.

Section A: Demographic Profile

(Answer by checking the appropriate box or writing your answer)

1. Age: _____

2. Gender:

☐ Male ☐ Prefer not to say

☐ Female

3. Occupation: _____

4. Length of residence in Barangay Poblacion:

☐ Less than 1 year ☐ 6–10 years

☐ 1–5 years ☐ More than 10 years

Section B: Community Needs and Usage

5. How often do you attend events in the barangay?

☐ Frequently ☐ Rarely

☐ Occasionally ☐ Never

6. What activities would you like the multipurpose hall to support? (Check all that apply)

☐ Meetings ☐ Cultural events

☐ Sports ☐ Educational programs

☐ Others: _____

Section C: Rainwater Harvesting Awareness

7. I am familiar with rainwater harvesting systems.

☐ Strongly Agree ☐ Neutral

☐ Agree ☐ Disagree

☐ Strongly Disagree

8. I support using harvested rainwater for non-drinking purposes (e.g., cleaning, gardening).

☐ Strongly Agree ☐ Neutral

☐ Agree ☐ Disagree

☐ Strongly Disagree

Section D: Passive Ventilation and Comfort

9. I prefer natural airflow over air conditioning in public buildings.

☐ Strongly Agree ☐ Neutral

☐ Agree ☐ Disagree

☐ Strongly Disagree

10. Good ventilation is important to me in a public space.

☐ Strongly Agree ☐ Neutral

☐ Agree ☐ Disagree

☐ Strongly Disagree

Section E: Suggestions and Feedback

11. What features would you like to see in the new multipurpose hall?

_____

12. Do you have any concerns or suggestions regarding the design or sustainability of the hall?

_____

Thank you for your time and valuable input. Your responses will help shape a more sustainable and community-friendly facility.